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Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-77, drawn to a method of forming a conductor, classified in class 438, subclass 627.
- II. Claims 78-185, drawn to a connective structure and a computer comprising a connective structure, classified in class 257, subclass 751.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process such as one in which rather than forming the trench in the insulator followed by depositing the barrier and conductive layer, these layers can be formed and patterned followed by depositing the insulator and etchback.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

Applicant is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Quach whose telephone number is (703) 308-1096. The examiner can normally be reached on Monday through Friday from 8:30 to 5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (703) 306-2794. The fax phone number for the organization where this application or proceeding is assigned is (703) 308-7722 or (703) 308-7724.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.



Tuan Quach
Primary Examiner

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DETAILED ACTION

Restriction/Election

1. Applicant's election of claims 1-77 without traverse in Paper No.8 is acknowledged. The restriction requirement is therefore made **FINAL**.

2. Claims 78-185 (Group II) are withdrawn from further consideration by the examiner, 37 CFR 1.142(b) as being drawn to a non-elected invention of a semiconductor device.

Objection to the Title

3 Due to Applicant's election of Group I claims in Paper No.8, the title of the invention is no longer descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

U.S.C. 112 § 1 Rejections

Scope of Enablement

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

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Claims 54, and 67, as well as all claims dependent thereof (i.e., claims 68-77), are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

- Claim 54 recites the step of depositing a seed layer of *titanium* on the oxide layer allegedly according to claim 50. However, claim 50 recites *aluminum-copper* as a seed layer deposited on the oxide layer. In order to proceed further with this Office Action, the Ti layer recited in claim 54 is understood as a barrier layer, as specified in the parent claim 50.
- Claim 67 recites the step of depositing a seed layer of copper on a previously deposited oxide layer. This is not possible, since the oxide layer would have been covered by the barrier layer deposited in a previous step. Even if the steps of depositing barrier layer and seed layer can be exchanged, one skilled in the art would have not been able to deposit both barrier layer and seed layer on the same oxide layer.

35 U.S.C. 103 (a) Rejections

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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Claims 1, 4, 8-10, 12, 15, 19, 23, 27, 30, 34, 38, 42, 45, 50, and 56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al.

- Dubin et al. disclose a method of forming a conductor comprising:
 - depositing an insulator 12, as shown in Fig.1 and recited in Col.1/II.32-34;
 - etching a trench 26 having a depth on the insulator, as shown in Fig.2A and disclosed in Col.3/II.65-67 and col.4/II.1-4;
 - depositing a barrier layer 22 on the insulator, as shown in Fig.2A and disclosed in Col.4/II.7-15;
 - depositing a seed layer 25 on the barrier layer 22, as shown in Fig.5 and recited in Col.4/II.29-39;
 - removing the barrier layer 22 and seed layer 25 from selected areas of the insulator, leaving a seed area, as shown in Fig.4 and recited in Col.5/II.8-11;
 - depositing a conductor 36 on the seed area by a selective deposition process, as shown in Fig.4 and recited in Col.4/II.27-29.

The claim does not preclude the additional step of depositing an intermediate layer 24 shown in Fig.2A or layer 24a,b in Fig.2B as part of the seed layer, as also incorporated in Applicant's invention by virtue of claim 26 (see later). Even if claim 1 would have been so amended such that any additional layer 24 is precluded, eliminating a layer from the prior art which is not required in Applicant's invention is considered obvious. Elimination of a step or element and its function is obvious if the function of the element is not desired

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or required; *Ex parte Wu*, 10 USPQ 2031 (Bd. Pat. App. & Inter 1989. See also *In re Larson*, 340 F.2d 965, 144 USPQ 347 (CCPA 1965); and *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975).

Further, the claim does not preclude a sequential exchange of the two last steps, i.e., removing the barrier & seed layers, and depositing a conductor layer on the seed layer, since the word comprising is being used to describe the steps sequence. Even if claim 1 would have been so amended such that the step of depositing the conductor layer is performed sequentially after the removing step, reversing the order of prior art process steps is held to render *prima facie* obvious; *Ex parte Rubin*, 128 USPQ 440 (Bd. App. 1959). As a matter of fact, selection of any order of performing process steps is *prima facie* obvious in the absence of new or unexpected results; *In re Burhans*, 154 F.2d 690, 69 USPQ 330 (CCPA 1946).

However, Dubin et al. do not deposit insulator layer 12 over a planarized surface. Ting et al. deposit an insulator layer 11 over a planarized upper or bottom surface of metal layer 10, as shown in Fig.1 and indicated in Col.8/ll.27-36, reciting the structure 10 as shown in Fig.1 as being only one of many structures present on a semiconductor device. The latter would certainly also include a planarized structure, as is well-known to one of ordinary skill in the art.

It would have been obvious to one having ordinary skill in the art at the time of the invention to deposit Dubin's insulator layer 12 over a planarized surface as shown in

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Ting's Fig.1, since it is an obvious matter of design choice to have a planarized or unplanarized structure underneath Dubin's insulator layer 12 or Ting's insulator layer 11.

Where the instant specification and evidence of record fail to attribute any significance (novel or unexpected results) to a particular arrangement, the particular arrangement is deemed to have been a design consideration within skill of the art. *In re Kuhle*, 526 F.2d 553, 555, 188 USPQ 7, 9 (CCPA 1975).

■ Claims 4, 8-10, 12, 15, 19, 23, 27, 30, 34, 38, 42, 45, 50, and 56, recite the same steps as claim 1, however, with specific material limitations imposed on the layers recited, as specifically addressed in the following:

- Regarding claims 4, 12, 15, 19, 23, 42, 45, 50, and 56, the limitation that the insulator layer is made of oxide is disclosed by Dubin et al. in Col.1/II.32-33.
- Regarding claims 8, 9, 27, 30, 34, 38, the limitation that the insulator layer is made of a polymer, specifically polyimide, is disclosed by Ting et al. in Col.8/II.36-44.
- Regarding claim 10, it is well known to one of ordinary skill in the art that polymer (claim 8), polyimide (claim 9) and foamed polymer (claim 10) are equally good as interlayer dielectric (ILD). Therefore, substituting polyimide in Ting's insulator layer 11 of Fig.1 with foamed polymer is not an act of invention, and hence, unpatentable. *In re Ruff*, 256 F.2d 590, 118 USPQ 340, 343 (CCPA 1958). Unpatentability not only applies where

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equivalency is disclosed in the prior art, but also where such equivalency would have been obvious. *Id.* at 599, 118 USPQ at 348.

It would have been obvious to one ordinarily skilled in the art at the time the invention was made to select any one of these materials as a suitable insulator layer of Ting's, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability (e.g., if low-k dielectric is desired) for the intended use as a matter of design choice. *In re Leshin*, 125 USPQ 416.

- Regarding claims 12, 15, and 56, the limitation that the barrier layer is made of tantalum or tantalum nitride is disclosed by Dubin et al. in Col.4/II.7-15.
- Regarding claims 19, 23, 27, 30, 34, 38, 42, 45, and 50, the limitation that the barrier layer is selected from a group consisting of titanium, zirconium, and hafnium, is disclosed by Ting et al. in Col.6/II.56-65, whereby it is expressly recited by Ting et al. that these metals - despite of being specified as seed layer - advantageously also serve as a diffusion barrier, as recited in Col.41-47.
- Regarding claims 12, 23, 27, 34, 38, and 56, the limitation that the seed layer is made of copper is disclosed by Ting et al. in Col.8/II.65-67.
- Regarding claims 15, 19, 27, 30, and 34, the limitation that the seed layer is made of gold or silver, is well-known in the art.

Regarding claims 42, 45, and 50, the limitation that the seed layer is made of aluminum-copper, is disclosed by Ting et al. in Col.4/II.16-25 and Col.4/II.40-42.

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- Regarding claims 15, 19, 23, 27, 30, 34, 45, and 50, the limitation that the conductive layer is made of gold, silver or aluminum, is well-known in the art.
- Specifically regarding claim 26, the limitation that the step of depositing **copper** on the seed layer of claim 26 comprises depositing **aluminum** on the seed area by selective CVD, is rendered obvious by Dubin et al. in Cu-Al alloy layer 24 shown in Fig.2A and Cu & Al layers 24a-b shown in Fig. 2B, as recited in Col.4/ll.16-25 and Col.4/ll.7-9.

6. Claims 2, 7, 11, 14, 17, 20, 25, 29, 32, 36, 40, 44, 47, 52, 54, 59, 60, 62, and 72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al.

- Regarding claims 2, 7, 11, 14, 17, 20, 25, 29, 32, 36, 40, 44, 47, 52, 54, and 62, the limitation that the barrier layer and/or seed layer is deposited either by the PVD or CVD method is well-known in the art, as recited by Dubin et al. in Col.1/ll.40-42, Col.4/ll.7-9, and by Ting et al. in Col.9/ll.8-10.

The limitation of PVD and CVD as a method of depositing the specified barrier and seed materials is a recitation of intended use (of a PVD or a CVD method). A recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use

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must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Such a manipulative difference is completely absent in the entire disclosure, including the claims.

- Specifically regarding claims 59 and 60, the limitation of non-anisotropic (i.e., isotropic) deposition technique is already included in Dubin's and Ting's, since PVD and CVD methods are known in the art as isotropic methods.

7. Claims 5, 6, 65, and 66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al.

- Regarding claims 5 and 65, the limitation that the oxide layer is silicon dioxide is disclosed by Dubin et al. in Col.1/II.32-33 and by Ting et al. in Col.8/II.36-44.

- Regarding claims 6 and 66, the limitation that the oxide layer is fluorinated silicon oxide is conventional. Fluorinated silicon oxide and silicon dioxide are known in the art as equivalent alternatives for interlayer dielectric (ILD). Therefore, substituting silicon dioxide in Dubin's insulator layer 12 of Fig.1 or Ting's insulator layer 11 of Fig.1 with fluorinated silicon oxide is not an act of invention, and hence, unpatentable. *In re Ruff*, 256 F.2d 590, 118 USPQ 340, 343 (CCPA 1958). Unpatentability not only applies where equivalency is disclosed in the prior art, but also where such equivalency would have been obvious. *Id.* at 599, 118 USPQ at 348.

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It would have been obvious to one ordinarily skilled in the art at the time the invention was made to select any one of these materials as a suitable Dubin's insulator layer 12 or Ting's insulator layer 11, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of design choice. *In re Leshin*, 125 USPQ 416.

8. Claims 18, 22, 33, 37, 41, 48, 49, 53, 55, 58, 63, and 64 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al.

- Regarding claims 18, 22, 33, 37, and 41, the limitation that the Cu seed layer is deposited by electroless deposition is disclosed by Dubin et al. in Col.1/II.47-53 and by Ting et al. in Col.10/II.17-24.
- Regarding claims 48 and 53, the limitation that the Al conductive layer is deposited on the seed layer by CVD is conventional, and hence well-known in the art.
- Regarding claims 49 and 55, the limitation that the Al conductive layer is deposited to an amount sufficient to fill the trench is trivial.
- Regarding claims 58 and 63, the limitation that the copper seed layer is deposited to a depth of approximately five-hundred angstroms thick, or to five-hundred angstrom below the top of the trench is trivial, since if it is deposited more than the specified amount, it is no longer a seed layer, but a conductive layer.

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- Regarding claim 64, the limitation that the TaN barrier layer is deposited above the conductor to a depth of approximately five-hundred angstroms is an obvious matter of design choice within skill in the art.

9. Claims 13, 16, 21, 24, 28, 31, 35, 39, 43, 46, 51, 57, and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al., and further in view of Nogami et al.

Dubin et al. as modified by Ting et al. show all the limitations of claims 13, 16, 21, 24, 28, 31, 35, 39, 43, 46, 51, 57, and 61, as previously applied to the respective parent claims 12, 15, 19, 23, 27, 30, 34, 38, 42, 45, 50, and 56, except for specific limitations to be addressed individually in the following:

- Regarding claims 13, 16, 21, 28, 31, 35, 39, 43, 46, 51, 57, and 61, the limitation that the barrier layer is deposited to a depth of between fifty angstroms and one thousand angstroms is well known to one of ordinary skill in the art. This Official Notice is factually supported by Nogami et al. in Col.6/II.56-59.
- Specifically regarding claim 24, the claim limitation is the same as that of claims 13 and 19 combined. Claim 24 is therefore rejected over the same prior arts as claims 19 and 13 combined, i.e., taking Nogami's as an additional prior art as applied to claim 13 above.

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10. Insofar as in compliance with 35 U.S.C. 112 § 2, claims 67-77 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Ting et al., and further in view of Nogami et al.

- Claim 67 recites the same limitations as in claim 1, further specifying the oxide layer as in claim 4, the barrier layer as in claim 12, the seed layer as in claim 27, the conductive layer as in claim 38, and an additional (barrier) layer on the conductive layer as in claim 56. Claims 1, 4, 12, 27, 38, and 56 having been previously rejected, claim 67 is therefore rejected for the same reason and over the same prior arts as claims 1, 4, 12, 27, 38, and 56, combined.

- Claim 68 recites the same limitations as in previously rejected claim 57.

- Claim 69 recites the same limitations as in previously rejected claim 58.

- Claim 70 recites the same limitations as in previously rejected claim 59.

- Claim 71 recites the same limitations as in previously rejected claim 61.

- Regarding claims 72 and 73, depositing TaN and Cu by the CVD method is conventional.

- Regarding claim 74, the limitation that the copper conductive layer is deposited to a depth of about five-hundred angstroms below the top of the trench is trivial, since space must be provided for the overlying TaN barrier layer to fill up the trench, as implicated in the parent claim 67.

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- Regarding claim 75, the limitation that the TaN barrier layer is deposited over the copper conductive layer to a depth of about five-hundred angstroms -- combined with the limitation of claim 74 -- is essentially the same as filling up the trench with Cu conductive layer of claim 74 and TaN barrier layer of claim 75, and hence, is trivial to one of ordinary skill in the art.
- Claim 76 recites the same limitations as in previously rejected claims 65 and 5.
- Claim 77 recites the same limitations as in previously rejected claims 66 and 6.

Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Technology Center 2800 fax center located in Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bernard E. Souw whose telephone number is (703) 305-3303. The examiner can normally be reached on Monday-Friday from 8:30 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudury, can be reached on (703) 306-2794. The fax number for the organization where this application or proceeding is assigned is (703) 308-7722 or -7724.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Technology Center receptionist at (703) 308-0956.

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September 25, 2000

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